STANDARD FOR LINED WATERWAY

Definition

A watercourse with an erosion resistant lining of concrete, stone or other permanent material. The lined section extends up the side slopes to design flow depth. The earth above the permanent lining shall be vegetated or otherwise protected.

Scope

This standard applies to waterways with linings of non-reinforced, cast-in place concrete; flagstone mortared in place; rock riprap or similar permanent linings. This standard does not apply to grassed waterways with stone centers. The maximum capacity of the lined waterway flowing at design flow depth shall not exceed 100 cfs.

Purpose

Waterways are lined to provide for safe disposal or runoff without damage by erosion or flooding in situations where grassed waterways would be inadequate.

Conditions Where Practice Applies

This practice applies where the following conditions exist:

1. The water velocity is such that lining is required to control erosion in the waterway.
2. Wetness, prolonged base flow or seepage would prohibit establishment of erosion-resistant vegetation.
3. The location is such that damage from use by people, vehicles or animals precludes use of vegetated waterways.
4. High value property or adjacent facilities warrant the extra cost to contain design runoff in a limited space.
5. Soils are highly erodible, highly acidic or other soil or climatic conditions precludes using vegetation.
6. On slopes greater than 10% the Standard for Slope Protection Structures shall apply.

Water Quality Enhancement

This standard is intended to protect larger capacity waterways from the extreme forces of erosion resulting from concentrated, high volume - high velocity flows. The primary benefit will be the prevention of soil loss from the channel lining surface. Subsequently, areas downstream will be protected from the deleterious effects of sediment deposition and conveyance of soil nutrients into local surface and groundwater systems.

Design Criteria

Capacity

Capacity shall be computed using Manning's formula or water surface profile models such as HEC RAS with a coefficient of roughness "n" as follows:

Table 20-1 Manning's "n" Values for Various Channel Lining Materials

LINING	"n" VALUE
Concrete	
Trowel finish	0.012 - 0.014
Float finish	0.013 - 0.017
Gunite	0.016 - 0.022
Cable or articulated block	Specified by manufacturer
Flagstone	0.020 - 0.025
Wire Mesh Stone filled baskets	0.025
Riprap	see the Standard for Riprap

Peak discharge values shall be determined by the following:

1. Rational Method - for peak discharge of uniform drainage areas as outlined in Technical Manual for Land Use Regulation Program, Bureau of Inland and Coastal Regulations Stream Encroachment Permits, Trenton, N.J. September 1997 or subsequent editions.

2. USDA-NRCS Win TR-55 or Win TR-20.

3. U.S. Army Corps of Engineers HEC HMS.

4. Other methods which produce similar results to the models listed above.

Minimum capacity and velocity shall be based on the 10 year frequency storm unless a larger storm event is to be conveyed for reasons of safety, compatibility with other stormwater management measures, etc.

Velocity

Maximum design velocity shall be as shown below. Except for short transition sections, slopes in the range of 0.9 to 1.10 of the critical slope must be avoided.

Table 20-2 Flow Depths and Velocities for Lined Waterway Design

DESIGN FLOW DEPTH	MAXIMUM VELOCITY
0.0 - 0.5' 0.5 - 1.0' > 1.0'	25 FPS 15 FPS 10 FPS

Lined waterways with velocities exceeding critical shall discharge into an energy dissipater to reduce velocity to less than critical.

Cross-Section

The cross-section shall be triangular, parabolic or trapezoidal. Monolithic concrete may be rectangular.

Freeboard

The minimum freeboard for lined waterways shall be 0.25 feet above design flow depth in areas where erosion resistant vegetation cannot be grown adjacent to the lined side slopes. No freeboard is required where good vegetation can be grown and is maintained.

Side slope

Steepest permissible side slopes, horizontal to vertical will be as follows:

Table 20-3 Side Slopes for Corresponding Lining Materials

LINING	STEEPEST PERMISSIBLE SIDE SLOPE
Non-Reinforced Concrete- Hand-placed, formed concrete Height of lining 1.5 feet or less	vertical
Hand-placed, screeded concrete or mortared in-place flagstone- Height of lining less than 2 feet Height of lining more than 2 feet	 1 to 1 2 to 1
Reinforced slip form concrete- Height of lining less than 3 feet	 1 to 1
Rock riprap	2 to 1

Lining Thickness

Minimum lining thickness shall be as follows:

Concrete

Poured in place, reinforced - 4.0 inches
Interlocking concrete blocks - per manufacturer's instructions
Cabled concrete - per manufacturer's instructions (non-corroding cable shall be used)

Rock riprap - as per Standard for Riprap

Flagstone - 4 inches including mortar bed

Related Structures

Side inlets, drop structures and energy dissipaters shall meet the hydraulic and structural requirements for the site.

Filters or bedding

For non-reinforced concrete flagstone linings, installation shall be made only on low shrink-swell soils that are well drained or where subgrade drainage facilities are installed.

Filters or bedding to prevent piping, prevent erosion, reduce uplift pressure and collect water will be used and will be designed in accordance with "National Cooperative Highway Research Program Report 108 - Tentative Design Procedures for Riprap-Lined Channels," USDA-NRCS procedures or other generally accepted methods. Weep holes and drains will be provided as needed.

Concrete or Mortar

Concrete or mortar shall meet New Jersey Department of Transportation Standard Specifications, Ref. #10, Appendix A11.

Rock Riprap or Flagstone

Stone used for riprap or flagstone shall be dense and hard enough to withstand exposure to air, water, freezing and thawing. Flagstone shall be flat for ease of placement.